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Diatom bloom in the Amba River, west coast of India: A nutrient-enriched tropical river-fed estuary

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ABSTRACT

The role of allochthonous nutrient inputs in governing phytoplankton distribution and abundance were assessed from the estuarine regions of the Amba River, west coast of India. A total of 35 species belonging to 24 genera were recorded, where the diatom *Coscinodiscus oculus-iridis* (99%) dominated the estuarine mouth with a density of 3.5×10^5 cells l^{-1}. Community analyses indicate that diversity (H') decreased towards the estuarine mouth (0.002 ± 0.001) compared to the middle (0.38 ± 0.06) and inner estuary (1.83 ± 0.14) due to the diatom outbreak. Chlorophyll *a* reached an average of 12.51 $\mu g\ l^{-1}$ at the estuarine mouth, which is over three times the value determined in the middle estuary ($4.25\ \mu g\ l^{-1}$). The key sources of these land-based nutrients are identified as agricultural land and urban runoff for nitrogen (N) and phosphorus (P), extensive sand mining for silica (Si) and aeolian deposition of iron minerals from industrial conveyor belts. A linear correlation between cell density and chlorophyll *a* with chemical variables indicated that silicate coupled with excess nitrogen input was crucial causative factors for the bloom. The nutrient enrichment towards the estuarine mouth is due to the dispersal of these land derived nutrients by complex hydrological forces.

1. Introduction

Phytoplankton is the primary biological component of the food web from which energy transfers to various trophic levels (Irwin et al., 2006; Madhu et al., 2007; Cloern et al., 2014). In the aquatic ecosystem, numerous abiotic and biotic factors regulate the abundance and composition of the phytoplankton population (Sin et al., 1999; Buzzi, 2002; George et al., 2013). However, the input of essential nutrients largely control the biological productivity in coastal waters. Global nutrient inputs have been significantly altered by human-induced land-use changes over the last century (Downing et al., 1999). Consequently, upsurges in relative nutrient concentrations have resulted in frequent incidents of eutrophication, hence altering the aquatic food web through unusual algal blooms in coastal environments (Rague-neau et al., 2002; Turner, 2002; Piehler et al., 2004). Favourable environmental conditions such as adequate nutrient supply, light, and temperature trigger the rapid proliferation of microalgae that eventually form blooms (Davidson et al., 2014; Zhou et al., 2017). These conditions were amplified in recent years as a consequence of increased anthropogenic pressures (viz. industrial effluents, untreated sewage and agricultural runoff) resulting in increased frequency of occurrence and severity of blooms (Robin et al., 2013; Wells et al., 2015; Whitehouse and Lapointe, 2015; Fang et al., 2018). Nearly twenty-five diatom blooms have been reported from Indian waters since 1923 (Bhat and Matondkar, 2004; Padmakumar et al., 2007; D'Silva et al., 2012; Karthik et al., 2014).

The Arabian Sea is considered highly productive due to seasonal upwelling (Prakash and Ramesh, 2007) however, the occurrence of frequent algal blooms are a sign of eutrophication. High levels of dissolved inorganic phosphate and silicate are derived from the riverine influx and resuspension of sediments (Muslim and Jones, 2003; George et al., 2013). Another important source that significantly enriches the coastal waters are nitrogen-based fertilizers from agricultural runoff (Anderson et al., 2002; Beman et al., 2005; Madhu et al., 2007; Heisler et al., 2008). The Amba River originates in the Western Ghats and trails a course of ~80 km before discharge into the Arabian Sea. The riverbank serves as a conduit for agricultural, industrial and domestic wastes. Concurrently, prolific economic development and population growth along this estuary, have led to increased nutrient supply to the coastal waters. Large fluvial inputs of anthropogenic nutrients appear to supplement the nutritional inadequacy of the Amba River with observed incidents of sudden proliferation of phytoplankton (Tiwari and Nair, 1998). Besides, recent studies suggest

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